TT 20: Cryotechnique & Measuring Devices: Poster Session

Time: Monday 15:00–18:00 Location: Poster D

TT 20.1 Mon 15:00 Poster D

Pulse Tube Cryocoolers: Solutions for "Dry" Cooling of Low Noise Applications at 4 K — •Jens Falter[1], Bernd Schmidt[1,2], Andreas Euler[1], Marc Dietrich[1,2], André Schirmeisen[1,2], and Günter Thummes[1,2] — [1]TransMIT-Center for Adaptive Cryotechnology and Sensors, Giessen, Germany — [2]Institute of Applied Physics (IAP), Justus-Liebig-University Giessen, Germany

Among the family of regenerative cryocoolers, Pulse Tube Coolers (PTCs) distinguish themselves from Gifford-McMahon- or Stirling coolers by the absence of cold moving parts inside the cold head. This features a long live operation with low vibration of the PTC and less maintenance compared to conventional cryocoolers - making them attractive for low noise applications. Since their invention, 4 K PTCs [1] have become an excellent alternative for "dry" cooling of cryogenic experiments without liquid helium ("wet") even below 4 K. Besides their advantages, PTCs - like all other regenerative cryocoolers - suffer from two intrinsic effects due to the periodic compression and expanding cycles in the cold head: a periodic elastic deformation ("breathing") of the thin walled pulse- and regenerator-tubes, which leads to residual vibrations and a periodic variation in temperature. Here we present unique applications of double-staged 4 K PTC based cryostats. By adapting the cooling power to the requirement of the experiment, the intrinsic effects of the PTC are minimized. Further decoupling and damping of the mechanical and thermal variations provide an excellent environment even for cooling of sensitive devices.

[1] G. Thummes, C. Wang, C. Heiden, Cryogenics **38**, 337 (1998)

TT 20.2 Mon 15:00 Poster D

Low-Noise Pulse Tube Cryocooler near 5 K: development of a system for operation of optical detectors — •Matthias Vorholzer[1,2], Bernd Schmidt[1,2], Jens Falter[1], Marc Dietrich[1,2], André Schirmeisen[1,2], and Günter Thummes[1,2] — [1]TransMIT-Center for Adaptive Cryotechnology and Sensors, Giessen, Germany — [2]Institute of Applied Physics, Justus-Liebig-University, Giessen, Germany

Pulse tube cryocoolers (PTC) are, beside Gifford-McMahon and Stirling-cryocoolers, an option for "dry" cooling down to liquid helium temperatures. A unique feature of the PTC, the absence of a moving displacer in the cold head, reduces the required maintenance compared to other cryocoolers and allows a setup with low mechanical vibrations. While plenty of development aims towards high cooling powers, for many applications cooling powers below 100 mW near 4-5 K are already sufficient for operation.

In the framework of the BMBF joint project "SUSY" (SUperconducting optical sensors based on a compact cryogen-free SYstem platform) we are developing a low-noise 2-stage 5 K PTC for cooling of transition edge bolometers and single-photon detectors with an input power of 1 kW or less. Reducing the vibrations is critical for those sensors and can mainly be achieved by reducing the pressure oscillation and downsizing the cold head. With only 1 kW input power and a considerable reduction in size the oscillatory displacement of the cold head is significantly lowered compared to typical PTC.

Work supported by the German BMBF under grant no. 13N13444

TT 20.3 Mon 15:00 Poster D

Current Sensing Noise Thermometer with Cross Correlated Readout for Milli-Kelvin Temperatures — •Felix Mücke, Andreas Reifenberger, Marius Hempel, Sebastian Kempf, Andreas Reiser, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, INF 227, Universität Heidelberg, 69120 Heidelberg

Within our search for easy-to-use reliable thermometers for milli-Kelvin and micro-Kelvin temperatures we recently developed a noise thermometer, where the Johnson current noise of a massive cylinder of high purity silver is monitored simultaniously by two current sensing dc-SQUIDs. The Si-Chip carrying the two SQUIDS is glued directly onto the noise source. Operating both SQUIDS in voltage biased mode in 2-stage SQUID configurations allows to reduce the power dissipation as well as the noise of the SQUIDS to a minimum. By computing the cross-correlation of the two SQUID signals the noise contribution of the read-out is suppressed to a level which is marginal even at micro-Kelvin temperatures. We present the thermometer design and discuss the results of experimental tests, where we compared the thermometer to a previously developed magnetic field fluctuation thermometer in the temperature range from 2.5 K down to 9 mK. Statistical uncertainties below 0.5 % are achieved within 10 s of measurement time. Within this uncertainty no self heating was observable at base temperature. This agrees with expectations from the thermal model of the thermometer, which suggests that self heating should be marginal even at temperatures well below 1 mK.

TT 20.4 Mon 15:00 Poster D

Experimental aspects of the specific heat of superconductors derived from topological insulators — •Lionel Andersen, Oliver Breunig, Thomas Lorenz, and Yoichi Ando — II. Physikalisches Institut - Universität zu Köln, Germany

The expectation for topological superconductors to have an unconventional pairing symmetry makes them promising hosts for Majorana fermions. Recently the topological insulators Bi_2Se_3 (BS) and $(PbSe)_5(Bi_2Se_3)_6$ (PSBS) were reported to become superconducting when intercalating them with copper [1, 2]. Literature data of specific heat on both, Cu_xBS and Cu_xPSBS, indicate an unusual temperature dependence not described by standard BCS theory [2, 3]. This makes them promising candidates of topological superconductors but in order to clarify these issues it is necessary to perform c_p measurements below 250 mK using a $^3He/^4He$ dilution cryostat. Because c_p of superconductors becomes very small far below T_c the addendum contribution of the setup has to be minimized. This demand together with other complications e.g. nuclear Schottky contributions to c_p, leads to a drastic increase of the experimental effort. In this contribution experimental aspects of c_p measurements with respect to the topological superconductor materials will be discussed in detail.

[1] Y. S. Hor et al., PRL **104** 057001 (2010)
[2] Y. Ando et al., PRB **90** 220504 (2014)
[3] Y. Ando et al., PRL **106** 127004 (2011)

TT 20.5 Mon 15:00 Poster D

Low temperature measurements of thermal conductivity and thermal diffusivity of thin metal films using the 3ω method — •Sofia Blanter[1], Sasmita Srichandan[1], Denis Kochan[2], and Christoph Strunk[1] — [1]Institut für experimentelle und angewandte Physik, Universität Regensburg, Universitätstr. 31, 93053 Regensburg — [2]Universität Regensburg, Institut I - Theoretische Physik, Universitätsstraße 31, 93053 Regensburg

We present measurements of thermal conductivity and thermal diffusivity for thin suspended membranes. The measurements are performed on 500 nm thick SiN membranes using the 3ω method [1]. We pass an AC current at a frequency ω through a metal transducer on top of the membrane. This applied current generates an oscillating heat flux through the membrane. This will create a modulation on top of the measured voltage through the transducer, at a frequency of 3ω.

By depositing thin metal films on the backside of the membranes, we are able to obtain thermal properties for thin metal films once the plain membrane is characterized. We derive a model from the two-dimensional heat diffusion equation, which allows us to extract both the thermal conductivity and thermal diffusivity of the sample.

[1] D. Cahill and R. Pohl, PRB **35**, 4067 (1987).

TT 20.6 Mon 15:00 Poster D

Design of a vector magnetometer for three dimensional magnetization measurements — •Markus Kleinhans, Marco Halder, Christopher Duvinage, and Christian Pfleiderer — Physik-Department, Technische Universitaet Muenchen, 85748 Garching, Germany

In magnetically ordered systems, the fundamental order parameter is the magnetization which is, in general, a three dimensional pseudovector. However, conventional magnetometers record the projection of the moment along the applied magnetic field hence missing key information of systems with complex magnetic anisotropies. We report the design of a bespoke set of pickup coils for a vibrating sample magnetometer that allow simultaneous measurements of all three components of the magnetization for temperatures down to 3 K and in magnetic fields up to 9 T. We demonstrate the potential of this technique in a study of selected anisotropic ferromagnets, namely Co, $Nd_2Fe_{14}B$, and $SmCo_5$.